Department of
Environmental Protection
Bureau of Land & Water Quality   February 2003

O&M Newsletter
A monthly newsletter for wastewater discharge licensees, treatment facility operators, and associated persons

Vulnerability Assessment

There is some evidence that we, at the Maine DEP, have long been concerned about the vulnerability of wastewater treatment plants. We have always encouraged/required plants to have at least minimal back-up generators, knowing that there are times when utility power is not available. We presented a series of high flow management training workshops because we know that high flows, especially in the spring in Maine, can cause a degradation of the effectiveness of the treatment process.

It would, however, be difficult to imagine regulatory and professional organizations like NEWEA, NEIWPCC, EPA and the Maine DEP making infrastructure security a major focal point prior to the events of 9/11. Now, unfortunately, we have to look not only at the potential vulnerability of treatment plant infrastructure to natural events, we must also focus on making facilities secure from man-made risks.

Wastewater Treatment Facilities and collection systems are one of America's most valuable resources. As cities and towns evaluate all of their tangible assets, many are finding that their wastewater treatment facility and collection system is their most valuable capital investment.

There are well over 130 publicly owned wastewater treatment facilities in Maine and our operators have been trying to deal with more stringent effluent limits including nutrient removal and control of metals. Although the vulnerability of the collection and treatment system to acts of man and nature was always a consideration in the design, construction and operation of waste-water treatment facilities, wastewater security was not a major focal point before 9/11/2001.

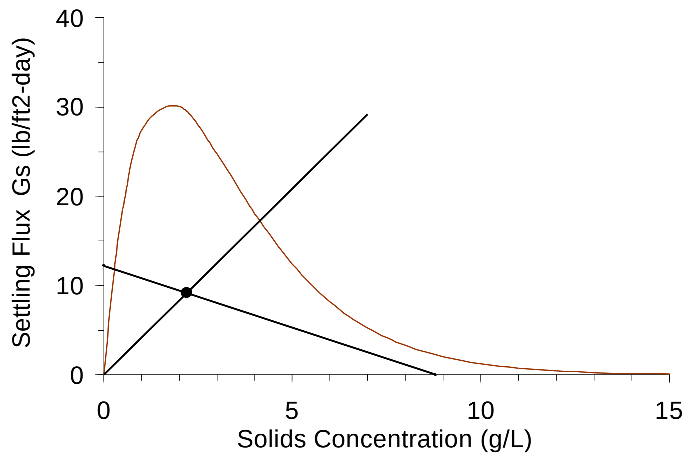
Nevertheless, it is important that all wastewater treatment facilities update their emergency operating and response plan or develop such a plan if they don't have one. During this process, operators should take the time to assess all of the system's vulnerabilities and determine what security measures must be implemented to assure the ongoing protection of public health and safety. Security considerations should be part of a sound management plan.

The Maine DEP has received funds from the EPA for vulnerability assessment work. We are in the planning to complete vulnerability assessments at several wastewater treatment facilities in Maine. If you are interested in participating in this project, please contact Dick Darling at 287-7806.

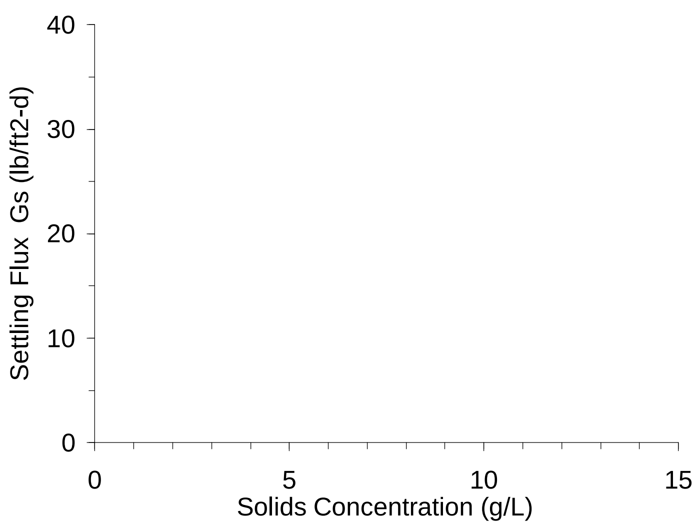
Clarifier Performance – Article 2 of 4

Last month, we discussed the mass balance in the secondary clarifier. Again, mass balance means that whatever goes into a clarifier must come out, be that water or solids. If the clarifier is working correctly, the solids come out of the bottom of the clarifier as return activated sludge (RAS) or waste activated sludge (WAS) and the clean water flows out over the weirs carrying little or no solids. This month, we'll talk about something called "State Point Analysis", which is a tool you can use to help you find out what the mass balance looks like in your clarifiers and how that will change with flow and solids loading to the clarifier. The term "State Point" refers to the "State" of the mass balance in the clarifier. That is, what is the mass balance of the clarifier at a given point in time... what is going in and what is coming out?

The State Point Analysis is done using a graph that looks something like the one below. In this graph, we have two straight lines that cross each other at the State Point and a curved line that rises and falls as the solids concentration increases



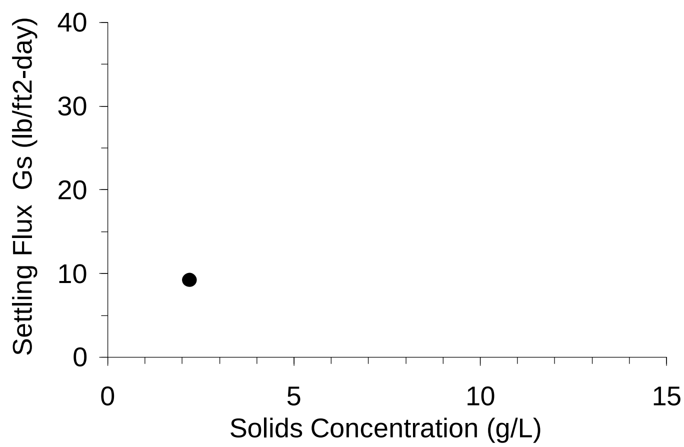
We begin the graph by setting up the axes. The y or vertical axis is the solids loading rate in pound per square foot per day (lb/ft^2-day). The x or horizontal axis is the solids concentration in grams/liter (g/L), which is milligrams/liter (mg/L) divided by 1,000. The "bare" graph is show below.



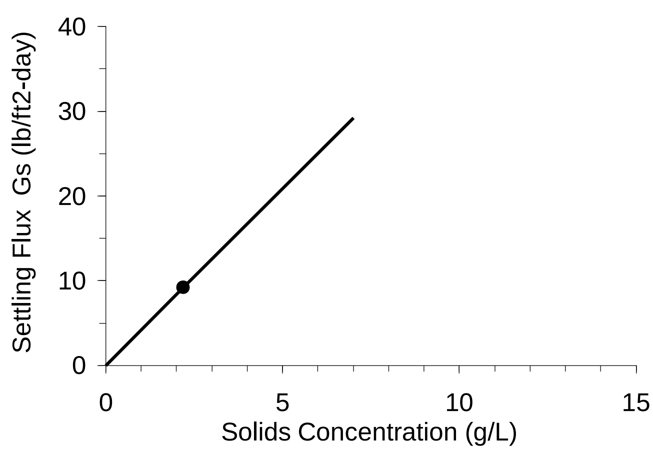
The solids loading rate (SLR) is, probably, the most important factor that will determine if your secondary clarifier works well. The design of many of the secondary clarifiers now being used in treatment facilities in Maine were based on the surface overflow rate (SOR) only. The SOR measures only the amount of water flowing through the clarifier. Since we are concerned with the mass balance of the solids in the clarifier, the SLR is really what we should be looking at. You calculate the SLR by multiplying the total flow coming into the clarifier, the influent flow plus the return flow ($Q + Q_{RAS}$) by the mixed liquor settleable solids concentration (X_{ML}) and dividing that quantity by the surface area of the clarifier (A). A little rearranging of the math gives us the formula for the SLR.

Equation 1 – $SLR = (Q/A)X_{ML} + (Q_{RAS}/A)X_{ML}$

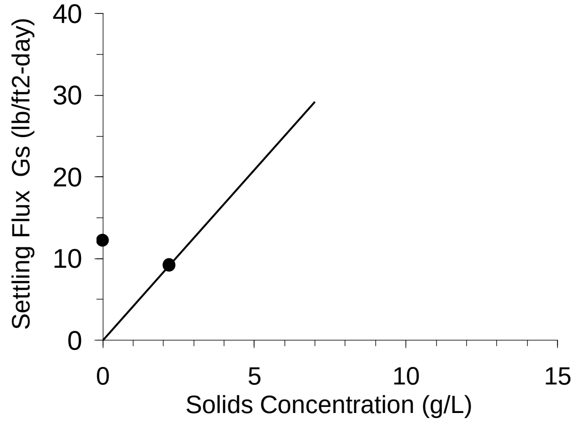
The first term in the equation above is used to plot the State Point. The y-coordinate of the point is (Q/A) X_{ML} and the x-coordinate is X_{ML}. The graph is shown below.



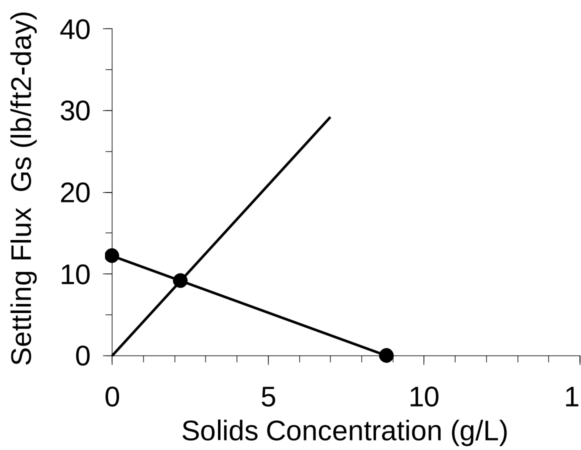
Next, we draw a straight line through the State Point and the Origin (0,0). The slope of this line is the surface overflow rate (SOR). The line is called the Overflow Rate Operating Line.



The total solids loading rate (SLR) is then computed using Equation 1 and plotted on the y-axis.



Now, we will draw a straight line from the SLR point through the State Point down to the x-axis. The slope of this line is the underflow rate, which is represented by $-Q_{RAS}/A$. The minus sign means that flow is leaving the clarifier. This line is called the Underflow Rate Operating Line.



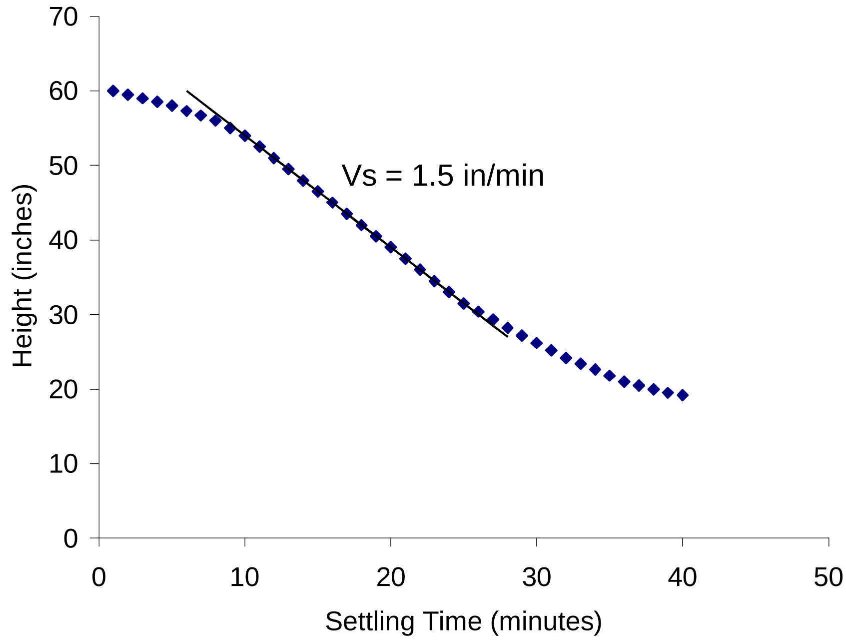
We've almost finished the graph that was shown at the beginning of this discussion. All we're missing is the curved line that goes up and down. The lines and points we've plotted so far relate to five of the six factors that determine secondary clarifier performance.

- T Clarifier Surface Area
  [Q/A & $-Q_{RAS}/A$]
- T Mixed Liquor Solids Concentration
  [$(Q/A)\ X_{ML}$ & $(-Q_{RAS}/A)\ X_{ML}$]
- T Influent Flow
  [Q/A]
- T RAS Flow
  [$-Q_{RAS}/A$]
- T Sludge Settling Characteristics

Clarifier Hydraulics

All the things checked off in the previous list (the size of the clarifier, the amount of flow, and the solids concentration) all depend on physical parameters. These parameters can be measured and, to some extent, controlled. Most operators know, however, that the quality of the secondary sludge determines whether we can hold solids in the system. The curved line on the State Point Analysis chart is determined by the sludge settling characteristics and to have that chart be useful for any purpose, we need to figure out the shape of that curved line.

If you take a large sample of mixed liquor with a MLSS of 2480 mg/L, put it in a six foot tall settling column, and measure the height of the top of the sludge blanket as the sludge settles, you will see a curve shaped something like the one below.

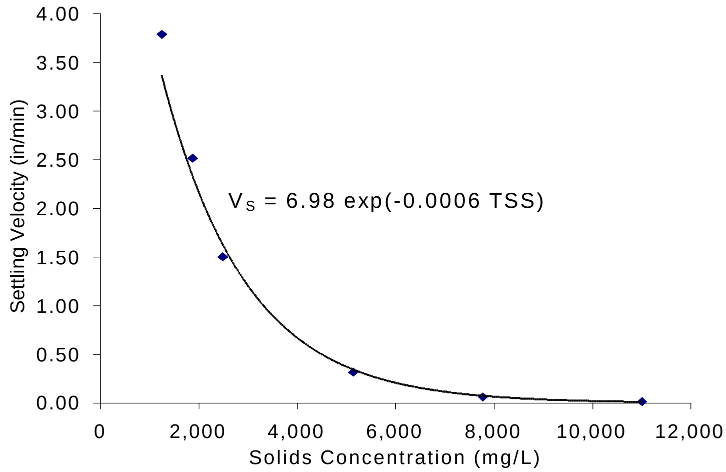


When we look at the curve, there is a section of the curve that is very close to being a straight line. If you draw a line through that section of the curve, the slope of the line gives you the settling velocity, as shown above.

You then repeat the test using various concentrations of mixed liquor and RAS as described in the following list.

Sludge Description	MLSS Concentration (X_{ML})	Settling Velocity (V_S)
Straight Mixed Liquor	2,480 mg/L	1.500 in/min
Straight RAS	7,770 mg/L	0.060 in/min
50/50 blend Mixed liquor and unchlorinated effluent	1,240 mg/L	3.790 in/min
50/50 blend of mixed liquor and RAS	5,130 mg/L	0.315 in/min
Concentrated RAS	11,000 mg/L	0.013 in/min
75/25 blend of mixed liquor and unchlorinated effluent	1,870 mg/L	2.515 in/min

If we plot the data from the various settling column runs, we get a graph that looks like the example on the top of the next page.



The equation of the curve is in the form: $V_S = V_O e^{-kx}$

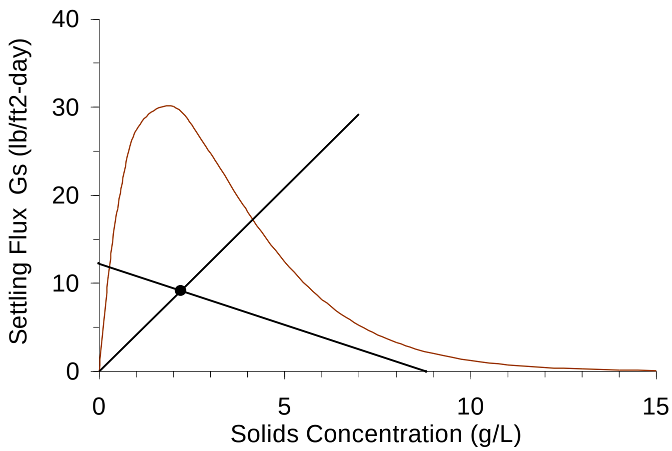
Where: V_S is the settling velocity and x is the TSS concentration of the sludge.
V_O (the initial settling velocity) and k (the settling rate) are defined by the settling characteristics of the sludge.

In the example above, the values of V_O and k are 6.98 in/min and –0.0006 L/g, respectively.

Once we have determined V_O and k, we can determine the Solids Flux (G). The Solids Flux is just like the solids loading rate. It is the amount or mass of solids that pass through a give area in a certain amount of time. Thus, it has the same units as the SLR, lb/ft^2-day. The Solids Flux is found by multiplying the settling velocity (V_S) by the solids concentration X_{ML}.

This gives the formula $G = X_{ML} \cdot V_S$ or $G = X_{ML} \cdot V_O e\text{-}^{kx}$

By computing the values for V_O and k, we can add the final piece of the State Point Analysis curve.



Next month, we'll discuss how to use the curve to determine how the clarifier will perform under different flows and solids loadings. We will also show how the State Point Analysis curve can teach us some things about what really happens in clarifiers.

For Practice

1. The pressure gauge on the discharge side of a pump reads 19 psi. What is the discharge pressure head?

   a. 55 feet
   b. 44 feet
   c. 33 feet
   d. 22 feet

2. for the most accurate test results, the preferred number of colonies on the plate of a *E.Coli* bacteria test is
   a. 200 - 500 colonies
   b. 100 - 200 colonies
   c. 20 - 60 colonies
   d. 10 - 20 colonies

3. The loading from your primary clarifiers to your aeration basin is fairly constant and your RAS concentration is also fairly constant. If you increase the RAS pumping rate, what will the effect be on the activated sludge process?
   a. The MLSS concentration in the aeration tank will decrease.
   b. The F/M ratio will go up.
   c. The OUR rate will decrease.
   d. The possibility of denitrification in the secondary clarifiers will be greater.

4. A rectangular channel is 18 inches across by 12 inches deep. If the water in the channel is 9 inches deep and moving at the rate of 4 feet per second, how much water will move through the channel in 2 hours?
   a. 16,200 gallons
   b. 91,000 gallons
   c. 243,000 gallons
   d. 162,000 gallons

Spring Certification Exam Notice

Note that the Spring certification exam will be given on May 14, 2003. Applications for that exam must be ***postmarked by March 29, 2003 or received by March 31, 2003***. If you missed out on the Fall exam, study up and take it in the Spring.

Operator Certification Renewals

Certified Operators who have ***odd numbered*** certificates will be due for renewal by March 1, 2003. Those operators received their renewal notices in early January. To renew your certificate, you need to show proof of at least 18 hours of approved training and pay the renewal fee of $20.00. If you are due to renew in 2003 and do not have enough training and cannot take the required 18 hours before March 1, 2003, submit your renewal form and renewal fee before march 1st. Include a letter stating when you will be taking the training to meet the 18 hour requirement. If we do not hear from you bay March 1, 2003, your certification will become inactive. If you are the operator in responsible charge of your treatment facility, it will be illegal for you to sign the DMR or Form 49 until you reactivate your certificate.

Approved Training

February 20, 2003 in Presque Isle, ME - Basic Excel for Water & Wastewater Operators - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.

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February 25, 2003 in Augusta, ME - Pump System Drives & Motors for Water & Wastewater Operators - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.

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February 26, 2003 in Kittery, ME – Instrumentation & SCADA – Sponsored by NEIWPCC, (978) 323-7929 – Approved for 6 hours.

March 6, 2003 in Portland, ME – Step by Step Basic Review for Water & Wastewater Operators - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.

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March 12, 2003 in Livermore Falls, ME - Phosphorus Removal to Improve Water Quality in Maine's Rivers, Lakes & Streams - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hrs.

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March 18, 2003 in North Vassalboro, ME - Basic Chemistry - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.

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March 27, 2003 in Bangor, ME – Developing a Capacity, Management, operation and Maintenance Program (CMOM) - Sponsored by JETCC, (207) 253-8020 – Approved for 3 hours.

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March 27, 2003 in Bangor, ME – Review of Maine's New Stormwater Rules - Sponsored by JETCC, (207) 253-8020 – Approved for 3 hours.

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April 9, 2003 in Presque Isle, ME - Using Advanced Technologies to Maintain Compliance Though residual control - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.

April 15, 2003 in Augusta, ME - Seeded BOD, E. Coli , Solids and Microscopic Examination – A hands on lab review - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.

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April 30, 2003 in Brewer, ME - Confined Space Entry - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.

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May 6, 2003 in Saco, ME - Physical Chemical Wastewater Treatment - Sponsored by JETCC, (207) 253-8020 – Approved for 6 hours.

May 21&22, 2003 in Bangor, ME, - Basic Lab Procedures w/ NEWEA Exam - Sponsored by NEIWPCC, (978) 323-7929 – Approved for 10 hours.

Answers to *For Practice:*

1. b 1 psi = 2.31 feet of water 19 * 2.31 = 43.89 which round up to 44 feet of water

2. c According to *Standard Methods*, the preferred number of colonies is 20-60 on a plate. This number is enough to assure that the count is reasonable and yet no too many to chance many multiple bacteria growing together to form a single colony.

3. c The Concentration of mixed liquor (MLSS) in the aeration tank will *increase* because less sludge will be returned to the aeration tank. The F/M ratio will *decrease* because the food (loading from the primary clarifiers) remains constant. The OUR rate will go down because there are less bugs to use the oxygen. The possibility of denitrification in the secondary clarifiers will *decrease* because more sludge is being withdrawn, giving a shorter detention time in the clarifiers.

4. c 18 in X 9 in = 162 sq. in = 1.13 sq.ft X 4 ft./sec. = 4.5 cu. ft./sec.
   4.5 cu. ft./sec. X 2 hr. X 60 min./hr. X 60 sec./min. = 32,400 cu. ft.. X 7.5 gal./cu.ft. = 243,000 gal.